frared beam passes through the rotating medium and a polarization analyzer, producing a modulated signal which contains the recorded information.

Erasure is by irradiating the material with a defocused visible beam whose polarization is rotated with respect to that of the original beam. Such erasing can be done "ad infinitum," according to Borrelli, although for best results writing energy should be kept low. Photochromics have two severe drawbacks. Because they're sensitive to visible light, a couple of minutes in a well-lit room can bleach the data away, Borrelli said. In addition, the material is relatively insensitive, requiring at least 200 millijoules per square centimeter for adequate contrast ratios.

Another erasable recording technique is to induce a crystal-to-amorphous transition in tellurium or a tellurium alloy. Because the crystalline form is both more reflective and more opaque than the amorphous material, such a disk could be used in either reflective or transmissive playback mode, notes David Strand, manager for optical memories at Energy Conversion Devices, Inc., in Troy, Michigan, which has developed such a medium.

Sensitivity of the company's material—which uses an unspecified combination of tellurium, selenium and sulfur—is about 10 mJ/cm², somewhat better than that of metal films for ablative recording. Writing wavelength can be between 400 and 800 nanometers, though slightly more energy is needed at longer wavelengths.

Because the crystalline/amorphous transition can be reversed simply by applying energy, data recording is completely erasable, Strand said. For reasons that are not well understood, it takes less energy to initiate the amorphous-to-crystalline transition than it does to go the other way; hence erase power need be only about half of the writing power. Spot size has not reached the material's limit.

Both the crystal and amorphous forms of the alloy are stable, because they are separated by an energy barrier. Hence data should not degrade with time in normal environments, Strand continued, while conceding the difficulty of obtaining accurate lifetime figures. He said that at moderate temperatures and high humidity the erasable material fared much better than an ablative disk, but that it degraded much faster than the ablative material at high temperature and moderate humidity. Strand emphasized that the material is still a research project and that the company is not near the product stage.

As a sideline to its tellurium trilayer project, RCA has developed a medium similar to the one at Energy Conversion Devices. RCA has used pure tellurium as well as an alloy for the top layer; an overcoat of silicon dioxide keeps the metal from ablating, and instead the energy goes into transforming the crystalline tellurium into amorphous form.

Magneto-optics is a third technique with promise for an erasable optical memory. In this approach, a laser heats the surface of an amorphous magnetic film above its Curie temperature. Subsequent cooling in the presence of an external magnetic field alters the magnetization direction of the heated spot in a predictable way. Data are erased by reversing the direction of the applied magnetic field, then repeating the recording process. To read the information, a laser beam is directed at the disk surface; the polarization of the reflected light depends on the direction of the magnetization of the medium at the point (the Kerr effect). Hence passing the reflected beam through a polarization analyzer yields an intensity-varying signal.

The most work on magneto-optic memories has been done at KDD Research and Development Laboratories in Tokyo. Researchers N. Imamura and C. Ota recently reported attaining data density of five megabits per square centimeter on a glass disk coated with films of terbium-iron or gadolinium-terbium-iron. That density is poor by optical-disk standards, because each magnetized spot interacts with its neighbors, preventing close packing.

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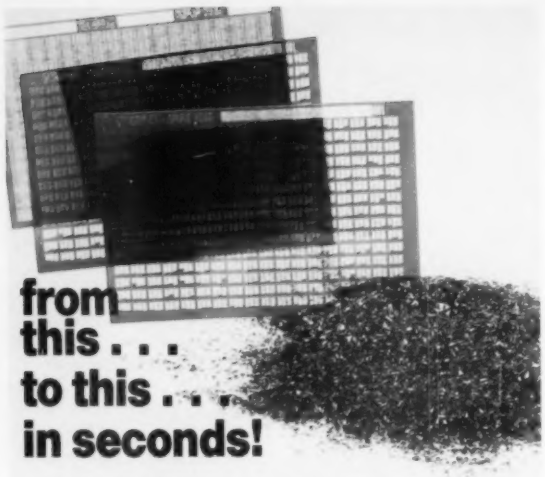

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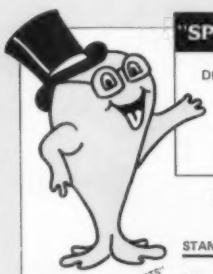

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